REMARKS/ARGUMENTS

Status of the Claims

Claims 1-130 are currently pending.

Claims 41, 45, 46, 49, 50, 53-60, 63-71, 87-123, 125, 126 and 128 have been allowed.

Claims 1-3, 9-34, 39, 42-44, 47, 48, 51, 52, 62, 72-86, 127, 129 and 130 are rejected.

Claims 4-8, 35-38, and 40-128 are allowable upon consideration of the prior art as indicated in the Paragraphs 10 and 11 of the Examiner's Office Action.

Applicants will now address the claim objections and rejections in the same order using the same paragraph reference numbers as presented by the Examiner in the current Office Action.

Paragraph 1. Claim Objections

The clerical errors in claims 6, 29, 40, 62 and 124, objected to by the Examiner, have been correct by amendments. Applicants believe that these objections raised by the Examiners are no longer at issue.

Paragraph 2-3. Claim Rejections- 35 USC§ 112

a. Claims 2, 42, and 51 have been rejected by the Examiner for indefiniteness and lack of clarity, because the claims include methanol, ethanol, hydrogen and carbon monoxide as part of the Markush group describing the possible vaporization hydrocarbon. The Examiner does not consider these compounds as hydrocarbons.

Applicants referred to these compounds as hydrocarbons because these compounds contain hydrogen and/or carbon, although they also contain oxygen. It is well accepted that an applicant is entitled to be his own lexicographer. Therefore, applicants may use the word hydrocarbons to refer to these hydrogen/carbon-contain compounds.

In the event Examiner prefers that these claims be amended to alleviate any likelihood of confusion, applicants would suggest that the word "hydrocarbons" in these claims be changed to "hydrogen/carbon-containing compounds".

The support for the applicants' the argument or amendments can be found at page 24, lines 19-24, in which these hydrogen, carbon and oxygen-containing compounds are referred to as hydrocarbons.

b. Claim 9 has been rejected by the Examiner for the reason that the term "the diffusion of hydrogen" lacks antecedent basis. The word "diffusion" has now been changed to "permeation". Claim 1 recites "hydrogen formed in said reaction zone **permeates** through said selective membrane" which now provides antecedent basis for the term "permeation", since claim 9 depends on claim 2 which in turn depends on claim1.

c. Claim 12 has been rejected for including methanol as one of the options for a vaporizable hydrocarbon. The same argument or amendment proposed in paragraph a. above is also applicable to this rejection.

d. In claim 30, the "the " in the term "the nitrogen oxide formation" has been deleted. This should alleviate the lack of antecedent basis issue raised by the Examiner.

e. The term "heating section" has been changed to "heaters" which word is recited in claim 40, which is the base claim for claim 44. The lack of antecedent basis rejection by the Examiner should no longer be at issue.

f. In claim 66, the markush language has been amended as suggested by the Examiner.

g. Claim 72 has been rejected because the claim recites that the vaporizable hydrocarbon is syngas, however the Examiner does not regard syngas as

a hydrocarbon. Again, the same arguments in paragraph a. above should apply to this rejection.

h. In claims 81 and 83, the improper Markush language, rejected by the Examiner, has been changed in accordance to the Examiner's suggestion.

i. In claim 127, the improper Markush language, rejected by the Examiner, has been changed in accordance to the Examiner's suggestion. It is to be noted that the Examiner rejected claim 129 for improper Markush language. Applicants believe that Examiner actually meant claim 127.

j. In claim 129, the term "the heating zone" has been deleted. Therefore the lack of antecedent basis rejection is no longer at issue. Again, Applicants believe that the Examiner meant to reject claim 129, although claim 130 was mentioned in paragraph j. of the rejection.

Applicants believe that the Section 112 rejections proposed by the Examiner are no longer at issue and the removal of the same is now respectfully requested.

Claim Rejections – 35 USC§102

Paragraph 5.

Claims 1-3, 11,12, 14-21, 23-31, 34, 39, and 129 have been rejected as anticipated by US Patent Number 5,997,594 (Edlund et al).

The Examiner takes the position that Edlund proposes a process for the production of hydrogen comprising the use of the instantly claimed flameless distributed combustion and thus anticipates the present invention. This is in view of the fact that Edlund provides heat to the reaction zone by employing a heating element including an oxidation catalyst surrounding at least a portion of the reaction zone.

Independent claims 1 and 34 of the present invention have been amended to particularly point out and distinctly claim an important aspect of the present invention, which relates to the specific way of achieving a "distributed" combustion in

the heaters via a "distributed" injection of fuel. The support for this amendment can be found at page 21, lines 9- 21 as well as page 23, lines 17-23. The present distributed combustion is accomplished by passing the fuel gas through a fuel tube having a plurality of openings or nozzles spaced along the length of the fuel tube. The fuel is mixed with the air or oxidants only after it is gradually released in a distributed and controlled manner. The distributed fuel injection design is advantageous as the amount of fuel mixing with the air or oxidant in the heater can be controlled to achieve the desired heat distribution along the heating section surrounding the reaction section.

Edlund employs a catalytic heater which is an oxidation chamber packed with catalyst (herein after "OCWC"), wherein fuel and air are separately injected into the heater through separate inlets and mixed in the heater. The mixture is catalytically ignited to generate heat. See Figure 7 of Edlund, in which fuel 421 is injected into the heater at 425b while air is injected via one port at 423 and the two streams are mixed in the heater and ignited when encounter oxidation catalysts.

The present process distinguishes from Edlund with respect to the following features:

(1) In the present process, the fuel is released in a controlled manner through a plurality of opening or nozzles spaced along the length of the fuel tube which extends along the heating area. The fuel is mixed with the air or oxidants only after it is gradually released in a distributed and controlled manner.

In contrast, Edlund just injects fuel into the heater and mixed with air. The fuel is not injected in a distributed manner. See column 11, lines 22-25; column 11, lines 51-59.

(2) The present process helps maintain a more uniform temperature, but simultaneously controls heat flux to match the local heat needed for the material left to be reacted. The heat flux profile can be designed by the nozzle locations and sizes, both in absolute flux size and in flux slop. Precise engineering of the heat flux will allow the reforming/reaction catalyst and hydrogen selective membrane to operate at near

isothermal conditions, and thus maximize reactor performance without any detrimental hot spot that will damage reforming/reaction catalyst or hydrogen selective membrane. Moreover, at the highest heat flux, there is as much heat present as can be accommodated by the reaction to be heated, and as the reaction process progresses less and less heat is required to drive the reaction and the present heat process is capable of providing heat in the controlled manner as needed.

In contrast, Edlund does not teach the concept of controlling heat flux through distributed and controlled fuel injection.

(3) Edlund uses combustion catalyst. Catalyst loading and deactivation can be an issue with Edlund.

In contrast, the present process does not require catalyst. Thus, catalyst loading and deactivation would not be an issue if catalyst is not used.

(4) The present process can effectively avoid hot spots in the heater. In contrast, Edlund has non-uniform heating as stated at column 12 lines 1-3: " The highest temperature combustion occurs when the mixture of fuel gas and combustion air first encounter catalyst 440, i.e. at the outlet of manifold 452."

(5) The present process is likely to experience less pressure drop in the heater than Edlund's heater which is packed with catalysts. Consequently, the present process is likely to involve less compression costs for the air and fuel in the heater.

(6) The present process may use heaters, each of which may have three tubes, a fuel tube , an air/oxidant tube, both are within a heater tube larger in diameter. This design is likely to have the advantage of reducing the maximum skin temperature of the heater and providing

heat integration between inlet and outlet streams (air and flue gas), thereby having better energy efficiency.

(7) Using as a heat source distributed combustion, of the present process, which provides great improvement in heat exchange efficiency and load-following capabilities to drive the steam reforming reaction. The flameless distributed combustion heat source used in the present process makes it possible to transfer between e.g. 90 and 95% of the heat to the reacting fluids.

(8) The present process has the advantage of having a negligible NOx production in the heaters.

Therefore, applicants believe that the presently process, as claimed in Claims 1-3, 11,12, 14-21, 23-31, 34, 39, and 129, is neither anticipated nor obvious over Edlund.

Paragraph 6

Claims 1-3, 9-16, 18, 19, 21-30, 32-34, 129 and 130 are rejected under 35 U.S.C. § 102(b) as anticipated by US Patent Number 5,639,431 (Shirasaki et al).

The Examiner again takes the position that Shirasaki proposes the instantly claimed process heated by a flameless distributed combustion, in view of the fact that Shirasaki provides heat to the reaction zone by employing a heating element including a combustion catalyst surrounding at least a portion of the reaction zone.

As discussed above, independent claims 1 and 34 have been amended to particularly point out and distinctly claim an important aspect of the present invention, which relates to the specific way of achieving a "distributed" combustion in the heaters via a "distributed" injection of fuel.

In contrast, Shirasaki's process injects fuel and air via a fuel inlet and an air inlet and fuel and air are mixed in the combustion chamber. The burners combust the mixed air and fuel with "flames" to provide heat for the reactions. See Figures 1, 5, 6, 7, 16-21, 25-27, 32, 33-34. and 44-46 which show flamed burners with fuel and air mixed in a non-distributed manner.

In the alternative, Shirasaki uses catalytic burners where air and fuel are mixed prior to encountering combustion catalysts. See Figures 4, 22 and 47. Again, the fuel is not distributed as provided in the present process.

Therefore, the present process, as claimed in claims 1-3, 9-16, 18, 19, 21-30, 32-34, 129 and 130, using distributed combustion, is neither anticipated nor obvious over Shrasaki for the same reasons stated in the arguments above in Paragraph 5 concerning Edlund.

Allowable Subject Matter

Paragraph 7

The Examiner considers claims 4-8 and 35-38 allowable if rewritten in independent form, since they are dependent upon a rejected base claim.

As discussed supra, applicants believe that the base claims 1-3 and 34 as amended are patentable. Thus, applicants also believe that claims 4-8 and 35-38 are also patentable in their current forms.

Paragraph 8

Claims 40, 42-44, 47, 48, 51, 52, 62, 72-86, 124 and 127 have been amended as suggested by the Examiner to over come the rejections under 36 U.S.C.§112 and objections set forth in the present Office action. Therefore, these claims are allowable as indicated by the Examiner in Paragraph 8 of the present Office action.

Paragraphs 9, 10, 11

Applicants acknowledge that claims 41, 45, 46, 49, 50, 53-61, 63-71, 87-123, 125, 126 and 128 have been allowed, and claims 4-8, 35-38, and 40-128 are allowable upon consideration of the prior art as indicated in the Paragraphs 10 and 11 of the Examiner's Office Action.

In view of the foregoing, claims 41, 45, 46, 49, 50, 53-60, 63-71, 87-123, 125, 126 and 128 have been allowed, and the remainder claims are all in condition for allowance. An early issuance of Notice of Allowance is now respectfully requested. In the event there is any issue or questions, the Examiner is invited to contact applicants' attorney.

Respectfully submitted,

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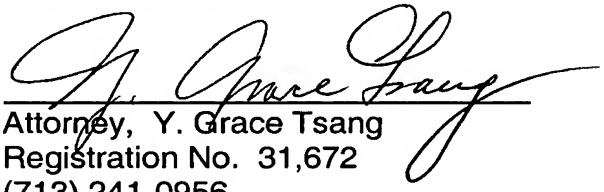
By: 

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